Z Rechtsmed (1989) 102:179–183

Zeitschrift für
Rechtsmedizin

Determination of calcium and magnesium in postmortem human vitreous humor as a test to ascertain the cause and time of death

R. Nowak and S. Balabanova

Institute of Forensic Medicine, University of Ulm, Prittwitzstraße 6, D-7900 Ulm, Federal Republic of Germany

Summary. The concentrations of magnesium and total calcium human vitreous humors obtained postmortem was tested. In the groups of heart disease and asphyxia a correlation between the postmortem interval and calcium or magnesium concentrations was found. There was no correlation between postmortem interval and calcium respectively magnesium in the other causes of death. It seems possible that the analysis of vitreous humor may be useful in both diagnosis and determination of postmortem interval in the cases of heart death and asphyxia.

Key words: Vitreous humor, determination of calcium and magnesium – calcium and magnesium in postmortem vitreous humor – Time of death

Zusammenfassung. Es wurden die postmortalen Konzentrationen von Magnesium und totalem Calcium im menschlichen Glaskörper bestimmt. Zwischen dem postmortalen Interval und den Magnesium- bzw. Calciumkonzentrationen in den Gruppen Herzversagen und Erstickung wurde eine signifikante Korrelation nachgewiesen. In den restlichen Gruppen war eine Korrelation zwischen den obengenannten Parametern nicht vorhanden. Die Ergebnisse deuten darauf hin, daß sich aus der Analyse der Glaskörper Anhaltspunkte für die Bestimmung der Todesursache und Todeszeitpunkt ableiten lassen.

Schlüsselwörter: Glaskörper, postmortale Calcium- und Magnesiumbestimmung – Calcium und Magnesium, postmortale Bestimmung im Glaskörper – Todeszeitbestimmung

Offprint requests to: R. Nowak

Introduction

Blood constituents analyzed postmortem are usually influenced by chemical changes or contaminations, e.g., by hemolysis, postmortem glycogenolysis (Hamilton-Paterson and Johnson 1940; Hill 1941; Hodgkinson and Hambleton 1969). Consequently, the values measured cannot be used to ascertain unsuspected antemortem serum abnormalities. In the contrary, the vitreous humor of the eye is by far less susceptible for chemical changes or contaminations. Determination of constituent values in the vitreous humor postmortem is facilitated to interpret antemortem abnormalities and time of death.

The purpose of this study was to determine the concentrations of magnesium and total calcium in human vitreous humor obtained postmortem as a test to ascertain the cause and time of death.

Table 1. Ca and Mg concentrations (mmol/l) mean ± SD, and range

Cause of death	*n*	Ca (mmol/l)		Mg (mmol/l)	
		Range	Mean ± SD	Range	Mean ± SD
Heart disease	19	0.9–2.9	1.81 ± 0.43	0.7–1.9	1.03 ± 0.26
Violence	11	1.3–2.0	1.58 ± 0.21	0.6–1.1	0.82 ± 0.16
Asphyxia	8	0.7–2.0	1.49 ± 0.43	0.7–1.4	0.89 ± 0.22
Drowning	10	1.0–1.9	1.42 ± 0.29	0.7–1.5	0.97 ± 0.22
Gunshoot injury	7	0.6–2.4	1.53 ± 0.58	0.6–1.9	1.0 ± 0.39

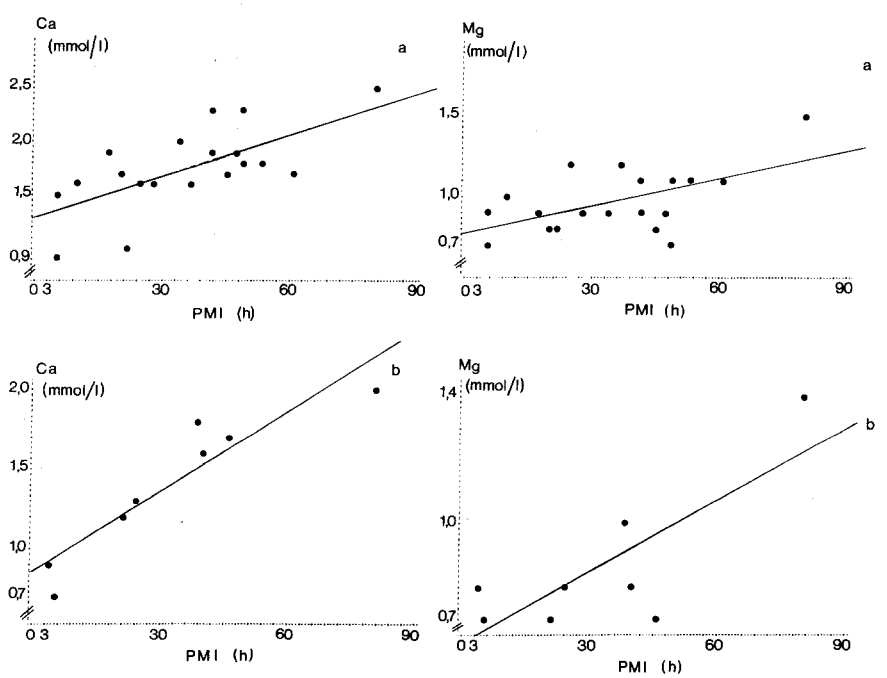

Fig. 1. Correlation between Ca and PMI, and Mg and PMI, respectively, in the groups of heart disease **(a)** and asphyxia **(b)**

Material and methods

Vitreous humor analyzed in the present study was obtained at autopsy from 37 male and 19 female patients (age range: from 2 month up to 84 years) with postmortem intervals of 3–192 h between time of death and sampling. The causes of death were heart disease (only coronary occlusion) ($n = 19$), violence ($n = 11$), suffocation (asphyxial and non ashyxial) ($n = 8$), drowning ($n = 10$), gunshoot injury ($n = 7$), and SIDS ($n = 1$). Vitreous humor was obtained by puncture of the sclera at the lateral canthus with a 20-ml plastic syringe and 20-gauge hypodermic needle. Samples contaminated with blood and samples not entirely clear were not used for analysis. The specimens were frozen at −20°C before being analyzed.

Ca and Mg concentrations were measured by automatic complexometric titration. The intraassay and interassay coefficients of variation were for Ca 4.5% ($n = 9$) and 5.2% ($n = 25$), respectively, and for Mg 5.4% ($n = 9$) and 6.3% ($n = 24$), respectively.

Results were expressed as mean ± SD and range. Correlations were tested by linear regression analysis. Data were statistically evaluated using the Wilcoxon test.

The postmortem VH Ca and Mg concentrations (range and mean) are listed in Table 1.

Correlation between the PMI and Ca or Mg were found only in the groups of heart disease and asphyxia (Ca: $r = 0.67$, $P < 0.001$; Mg: $r = 0.56$, $P < 0.01$ for the group of heart disease, and Ca: $r = 0.92$, $P < 0.001$; Mg: $r = 0.78$, $P < 0.001$ for the group of asphyxia, respectively) (Fig. 1).

The relationships of PMI with mean values of Ca or Mg are represented by the equations below:

Table 2.

Cause of death	PMI and					
	Ca			Mg		
	Equations		r	Equations		r
Heart disease	PMI =	0.013x + 1.28	0.67	PMI =	0.0056x + 0.77	0.56
Violence	PMI =	0.012x + 1.37	0.60	PMI =	0.001x + 0.77	0.08
Asphyxia	PMI =	0.017x + 0.85	0.92	PMI =	0.0076x + 0.62	0.78
Drowning	PMI =	−0.0018x + 1.50	−0.33	PMI =	−0.0003x + 0.99	−0.20
Gunshoot injury	PMI =	0.015x + 1.11	0.60	PMI =	0.00088x + 0.76	0.51

No correlation between Ca and Mg values was observed. The Ca and Mg concentrations measured in the SIDS fatalities were 1.6 mmol/l and 1.4 mmol/l, respectively.

No difference between Ca and Mg values in male and female patients were found.

Discussion

The Ca and Mg concentrations measured in VH are not significantly different from those reviewed by other authors (Coe 1969; Coe 1972; Gregora and Kratochvil 1978; Killey et al. 1980; Wilkie and Bellamy 1982; Dufour 1982). Our results showed a significant correlation between PMI and Ca or Mg only in two groups, viz., heart disease and asphyxia (Table 2, Fig. 1). The coronary occlusion can be considered as one form of asphyxia. Endothelial lesions as a result of as-

phyxia can be followed by disturbances of the blood-eye barrier. Consequently, the inflow of Ca and Mg from blood into the vitreous humor increased. However, this hypothesis remained to be investigated.

Coe (1969, 1972) and Gregora and Kratochvil (1978) described also a correlation between PMI and Ca. However, a correlation between Mg and PMI was not observed (Blumenfeld and Mantell 1974; Tantchou et al. 1978; Gregore and Kratochvil 1978).

Drowning as a cause of death was considered as separate group. In this study, we observed a negative statistically not significant correlations between PMI and Ca or Mg values in this group. This inverse relation can be explained with the dilution and enhancement, respectively, of Mg in the vitreous humor. These results are in accordance with the observations of Rammer and Gerdin (1976), Foroughi (1971), Bray et al. (1983), and Nowak and Sachs (1986).

The Ca and Mg concentrations in SIDS observed in this study were not different from the concentrations in the remaining groups. Blumenfeld and Mantell (1974), Emery et al. (1974), Peterson and Beckwith (1973), Sturner (1972), and others observed also no difference between Ca and Mg in SIDS fatalities and other death causes.

In conclusion, based on the present observations it seems possible that analysis of vitreous humor may be a useful adjunct to diagnosis and determination of the PMI in the cases mentioned above.

References

Blumenfeld TA, Catherman RL (1974) Post-mortem vitreous concentration of Na, K, Cl, Ca, Mg in sudden infant death syndrome (SIDS). Pediatr Res 9:347

Blumenfeld TA, Mantell CH (1974) Post-mortem vitreous chemistry in sudden infant death syndrome and in other causes in death in childhood. Am J Clin Pathol 71:219–223

Bray M, Luke JL, Blackbourne BD (1983) Vitreous humor chemistry in deaths associated with rapid chilling and prolonged freshwater immersion. J Forensic Sci 28:588–593

Coe JI (1969) Post-mortem chemistries on human vitreous humor. Am J Clin Pathol 51:741–750

Coe JI (1972) Use of chemical determinations of vitreous humor in forensic pathology. J Forensic Sci 17:541–546

Dufour DR (1982) Lack of correlation of postmortem vitreous humor calcium concentration with antemortem serum calcium concentration. J Forensic Sci 27(4):889–893

Emery JL, Swift PGF, Worthy E (1974) Hypernatriaemia and uraemia in unexpected death in infancy. Arch Dis Child 49:686–692

Foroughi E (1971) Serum changes in drowning. J Forensic Sci 16:269–282

Gregora Z, Kratochvil J (1978) Mnozstvi drasliku a vapniku v ocnim sklivci v zavislosti na dobe smrti. Clesk Patol 14:1–7

Hamilton-Paterson JL, Johnson EWM (1940) Post-mortem glycolysis. J Pathol Bacteriol 50: 473–482

Hill EV (1941) The significance of dextrose and non-dextrose reducing substances in post-mortem blood. Int Arch Pathol 452–473

Hodgkinson A, Hambleton J (1969) Elevation of serum calcium concentration and changes in other blood parameters after death. J Surg Res 10:567–574

Killey FP, Edelhauser HF, Aaberg TA (1980) Intraocular fluid dynamics. Arch Ophthalmol 98:1448–1452

Nowak R, Sachs H (1986) Das Verhalten der Glaskörperalkoholkonzentration (GAK) unter verschiedenen Lagerungsbedingungen. Blutalkohol 23:251–261

Peterson DR, Beckwith JB (1973) Magnesium deprivation in sudden unexpected infant death. Lancet 2:330

Rammer L, Gerdin B (1976) Dilution of blood in fresh-water drowning. Post-mortem determination of osmolarity and electrolytes in blood, cerebrospinal fluid and vitreous humor. Forensic Sci 8:229–234

Sturner WQ (1972) Magnesium deprivation and sudden unexpected infant and death. Lancet 2:1150

Swift PGF, Worthy E, Emery JL (1974) Biochemical state of the vitreous humor of infants at necropsy. Arch Dis Child 49:680–685

Tantchou J, Yu L, Toppin M (1978) Comparison of chemical analysis of the vitreous humor of human eye and cow's eye. Clin Biochem 11:4

Wilkie JW, Bellamy JEC (1982) Estimation of antemortem serum elektrolytes and urea concentrations from vireous humor collected post-mortem. Am J Comp Med 46(2):146–149

Received April 12, 1988